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### (54) Consolidated duplex heat exchanger.

(57) A consolidated duplex heat exchanger includes a first unit heat exchanger used for instance as a radiator, and a second unit heat exchanger employed for instance as condenser for a car-cooler. The two unit heat exchangers (10 and 20) are juxtaposed parallel with and close to each other and united together by common corrugated fins each extending between cores of the unit heat exchangers. The corrugated fins are provided with cutouts (2) intermediate the two unit heat exchanger parts so as to intercept undesirable heat conduction between the unit heat exchangers.

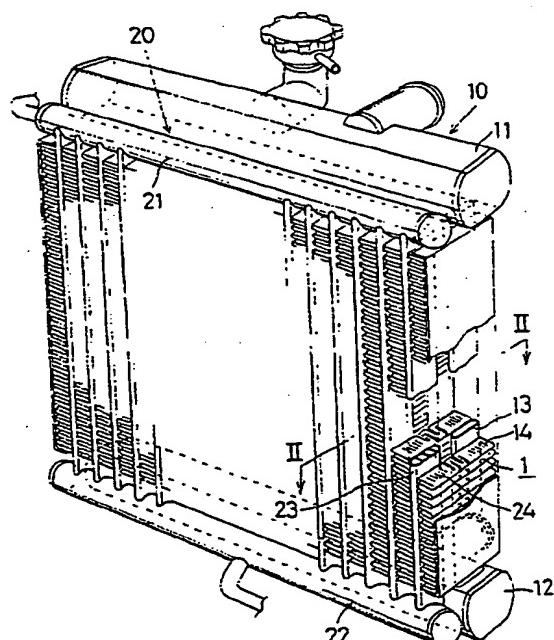


FIG. 1

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The invention relates to a consolidated duplex heat exchanger and more particularly relates to a heat exchanger comprising different kinds of unit heat exchangers such as an engine cooling radiator and an air-conditioning condenser in automobiles wherein the unit heat exchangers are arranged parallel and consolidated into the duplex heat exchanger.

Heat exchangers for automobiles are now required on the one hand to be more compact in order to reduce the space for installation and also on the other hand to decrease the work for assembling them. Therefore, a pair of unit heat exchangers of different kinds are often combined to form a consolidated duplex heat exchanger in the case where the unit heat exchangers are arranged close together. Examples of such combinations of unit heat exchangers include a pair comprising a radiator for the engine and a condenser for the car cooler, a pair comprising a heater core and an evaporator and a pair comprising the radiator and an intercooler.

One type of such consolidated heat exchanger is already disclosed in the Japanese Patent Publication Kokai 1-247990. This heat exchanger has a basic configuration as shown in Figs. 6 and 7 wherein a second unit heat exchanger 20 constituting for instance a condenser for a car cooler is installed in parallel with and in front of a first unit heat exchanger 10 constituting a radiator. These unit heat exchangers are consolidated into one duplex heat exchanger. The first unit heat exchanger has a structure such that a number of flat tubes 13 are arranged parallel with each other and connected to an upper and lower header tanks 11 and 12 in fluid communication therewith. Corrugated fins 14 are interposed between one such flat tube and the adjacent one. Similarly, the second unit heat exchanger 20 is so constructed that a number of parallel flat tubes 23 are connected at their opposite ends to upper and lower header tubes 21 and 22, respectively, with corrugated fins 24 interposed between one such flat tube and the next.

In the above-mentioned consolidated heat exchanger, it is already proposed that, as disclosed in the above noted Japanese Patent Publication and shown in Fig. 8, the first and second unit heat exchangers may have the same corrugated fins jointly so as to simplify the assembling process and improve the strength of the connection between the two unit heat exchangers. Opposite ends of each corrugated fin are respectively connected to the unit heat exchangers.

However, the prior art consolidated heat exchanger comprising the common corrugated fins will inevitably cause thermal interference due to the continuous common fins 14 and 24 extending between the first and second unit heat exchangers 10 and 20. If the unit heat exchangers work at different temperatures, then heat from one unit heat exchanger working at a higher temperature will affect the other unit heat exchanger working at a lower temperature to

thereby reduce the efficiency of the heat exchange.

It will thus be necessary to increase the distance between the unit heat exchangers 10 and 20 to a satisfactory degree in order to minimize such a thermal interference. This will bring about a serious problem that the greater the distance, the less compact would be the consolidated heat exchanger against its expected task.

An object of the invention is to overcome this problem and therefore to effectively avoid any significant thermal interference between first and second unit heat exchangers, without impairing the compactness of a consolidated heat exchanger composed of the unit heat exchangers.

In order to achieve this object, corrugated fins co-owned by the first and second unit heat exchangers operating at different temperatures are characteristically provided with one or more cutouts at intermediate horizontal portions of each fin in order to intercept heat conduction from one unit heat exchanger to the other.

The cutouts may be provided to be of any shape insofar as they intercept at least partially the continuity of the corrugated fins extending in vertical direction between the first and second unit heat exchangers. One or more notches, circular holes or the like may be disposed at the intermediate portions of each corrugated fin, ranging top and bottom thereof. In the most preferable structure, a plurality of the notches are formed alternately from one of opposite side edges to the other of the intermediate portions and vice versa. This configuration is most advantageous because the length of heat conduction path between the two unit heat exchangers is significantly increased.

It will be apparent that in the duplex heat exchanger in accordance with the invention the cutouts formed at horizontal intermediate portions of each corrugated fin will intercept without failure the heat conduction through said corrugated fins from one unit heat exchanger to the other. As a result, the amount of heat conducted between the two unit heat exchangers is so remarkably reduced that any one of the unit heat exchangers scarcely influences thermally the other unit heat exchanger, even if they are positioned closely to each other. Thus, the mutual thermal interference is effectively avoided and it is no more necessary for the two unit heat exchangers to be spaced apart from each other such a great distance as impairing the compactness of the consolidated duplex heat exchanger.

In addition, since the duplex heat exchanger in accordance with the invention is of such a consolidated structure that the first and second unit heat exchangers co-own the common corrugated fins, the whole assembly can be built by the one-shot soldering process at a sufficiently high productivity.

Apart from the avoidance of thermal interference,

the cutouts can prevent condensed water from flowing from a surface of evaporator towards a heater core in a case wherein the evaporator is the first unit heat exchanger, with the heater core being employed as the second unit heat exchanger. Consequently, such condensed water on the evaporator will never hinder the heater core from radiating heat.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which :—

Fig. 1 is a perspective view showing in part a consolidated duplex heat exchanger according to an embodiment of the invention ;

Fig. 2 is a horizontal cross-section on the line II-II of Fig. 1 and partially showing a core part in the consolidated duplex heat exchanger ;

Fig. 3 is a perspective view partially showing the laid down state of a corrugated fin incorporated in the duplex heat exchanger as shown in Figs. 1 and 2 ;

Fig. 4 is a plan view partially showing modified types of cutouts formed in the corrugated fins ;

Fig. 5 is a further plan view also partially showing another modified type of the cutouts ;

Fig. 6 is a front elevation showing a prior art consolidated duplex heat exchanger as a whole ;

Fig. 7 is a side elevation showing in part the prior art heat exchanger ; and

Fig. 8 is a horizontal cross section taken along a line VIII-VIII in Fig. 7 and partially showing a core part.

Referring now to Figs. 1 to 3, a consolidated duplex heat exchanger in an embodiment of the invention is basically similar to the prior art one in respect of the structures of a first and second unit heat exchangers 10 and 20 which are united together. Reference numerals which are the same in Figs. 1 to 3 and in Figs. 6 and 7 denote the same or similar members in the duplex heat exchangers. Corrugated fins 1 which are co-owned by the two unit heat exchangers 10 and 20 in the embodiment are however improved in a unique manner in the invention.

Each corrugated fin 1, which combines the first and second unit heat exchangers 10 and 20 in the consolidated duplex heat exchanger in the embodiment, comprises at its horizontal intermediate portion a plurality of notches 2 which function as cutouts to intercept heat conduction. The notches 2 are narrow elongate slits and are provided by cutting out portions of the fin 1 alternately in opposite directions from an edge and from another edge. The plurality of notches 2 extending in a direction of height "H" in Fig. 3 are arranged zigzag. As indicated by arrowed broken lines in Fig. 3, heat conduction path "a" extends zigzag between fin portions 14 and 24 which respectively belong to the first and second unit heat exchangers 10 and 20. In other words, the heat conduction path "a" of zigzag pattern consists of a continuous portion 3 of

each corrugated fin from which the notches 2 are cut out, thereby enhancing a substantially increased length to the heat conduction path.

In one of desirable designs of the notches 2 in a case wherein the height "H" of the fins is for instance 5 to 16 mm, two or more slits 2 are arranged in alternating opposite directions within a region which extends a distance  $\ell$  between the first and second unit heat exchangers 10 and 20. Each notch 2 is "0.7 H" or more in height "S", and a pitch "P" of notches, that is, a distance between the two adjacent notches desirably falls within a range of "0.1 H" to "0.3 H".

In the consolidated duplex heat exchanger described above, only a less amount of heat is conducted through each corrugated fin 1 because the narrow heat conduction path "a" is significantly longer than distance  $\ell$  between the unit heat exchangers. Owing to such a feature, the distance  $\ell$  between the first and second unit heat exchangers 10 and 20 can be made so short as to make more compact the duplex heat exchanger as a whole, and nevertheless the undesirable thermal interference between the two unit heat exchangers 10 and 20 can be avoided almost perfectly.

The notches 2 may be provided by the "partially slitting and bending" method to form lugs similar to louver 4 provided on the fin parts 14 and 24 belonging to the first and second unit heat exchangers 10 and 20.

Further in a modification of the embodiment, the cutouts for interception of heat conduction are circular holes 5 drilled through the portions located intermediate in a direction of height of the corrugated fins, as shown in Fig. 4. In another modification, the cutouts are slots 6 drilled parallel with each other through said intermediate portions in said direction, as shown in Fig. 5. Decreased surface area of heat conduction path in both the modifications due to the cutouts 5 or 6 will play a prominent role in diminishing the heat conduction between the first and second unit heat exchangers 10 and 20.

#### Claims

1. A consolidated duplex heat exchanger comprising a first unit heat exchanger, a second unit heat exchanger, the two unit heat exchangers operating at different temperatures, and corrugated fins co-owned by and thereby consolidating the two unit heat exchangers into the duplex heat exchanger, characterized in that the corrugated fins (1) comprising at their intermediate portions in a direction of width one or more cutouts (2) to intercept heat conduction between the two unit heat exchangers (10 and 20).
2. A consolidated duplex heat exchanger according

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to claim 1, characterized in that both the first and second unit heat exchangers (10 and 20) comprise a pair of headers (11 and 12) with a space between them and a plurality of tubes (21 and 22) disposed parallel with each other between the headers and having opposite ends in liquid communication therewith, the corrugated fins (1) each being interposed between the two adjacent tubes.

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3. A consolidated duplex heat exchanger according to claim 2, characterized in that the cutouts are notches (2) formed by partially slitting the corrugated fins alternately from an edge and from another edge in opposite directions of height of the fins.

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4. A consolidated duplex heat exchanger according to claim 3, characterized in that the height "S" of the notches (2) is "0.7 H" or more, "H" being height of the corrugated fins, and pitch "P" of the notches is "0.1 H" to "0.3 H".

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5. A consolidated duplex heat exchanger according to claim 1, characterized in that the cutouts are circular holes (5) drilled through the intermediate portions in a direction of height of the corrugated fins.

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6. A consolidated duplex heat exchanger according to claim 1, characterized in that the cutouts are slots (6) drilled through the intermediate portions in a direction of height of the corrugated fins.

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7. A consolidated duplex heat exchanger according to claim 1, 2 or 3, characterized in that the first unit heat exchanger is a radiator used for cooling an automobile engine and the second unit heat exchanger is a condenser used for air-conditioning an automobile room.

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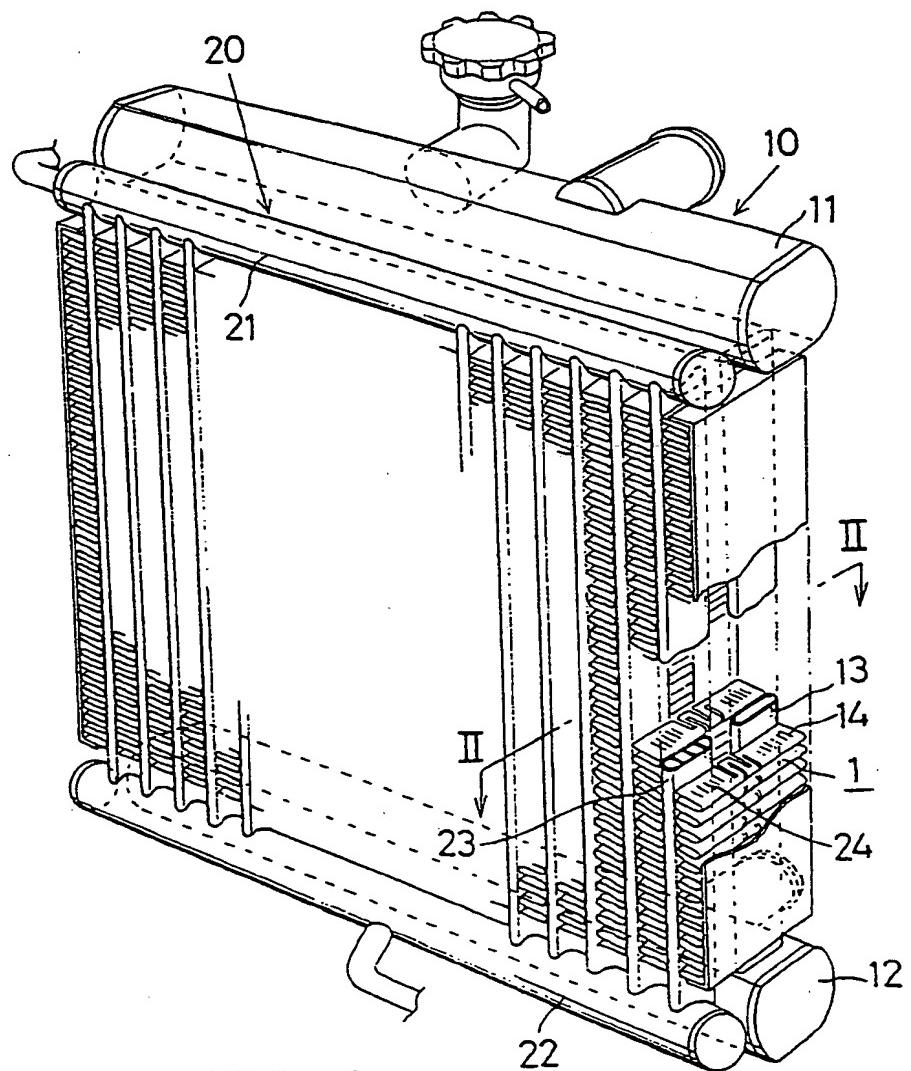


FIG. 1

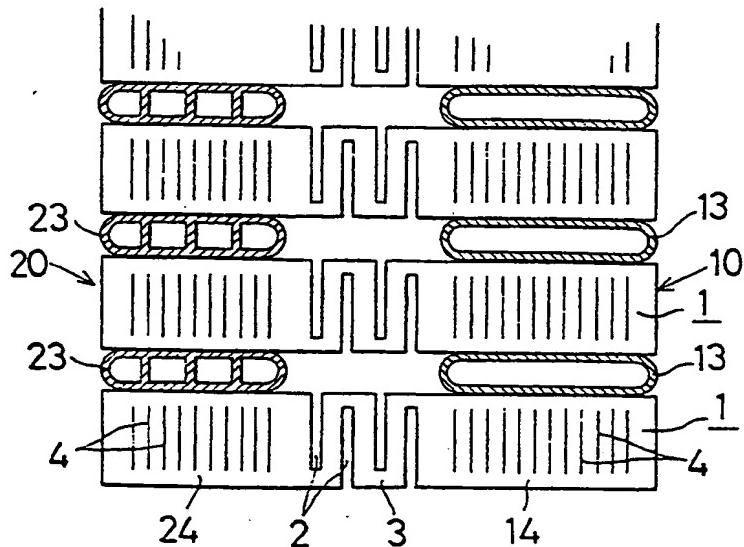


FIG. 2

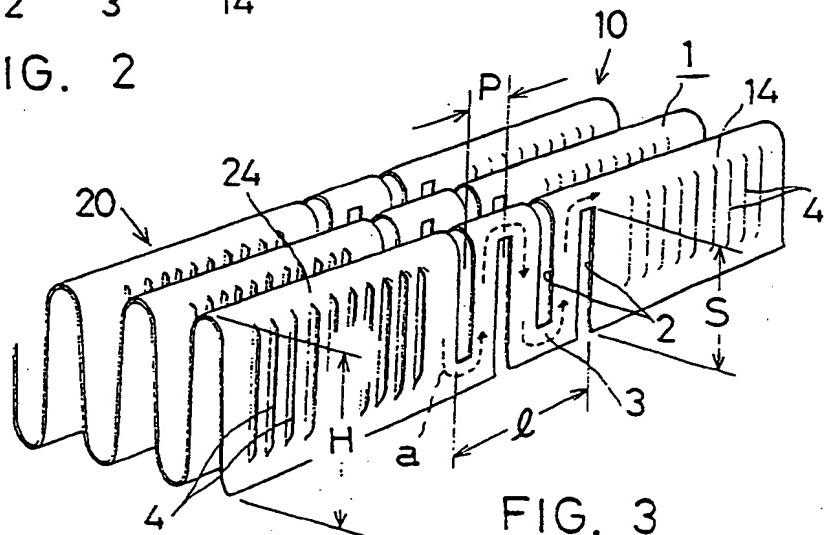


FIG. 3

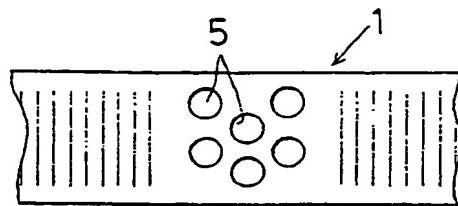


FIG. 4

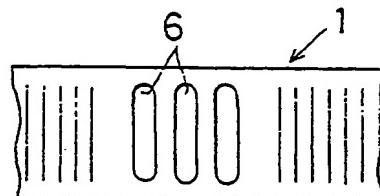


FIG. 5

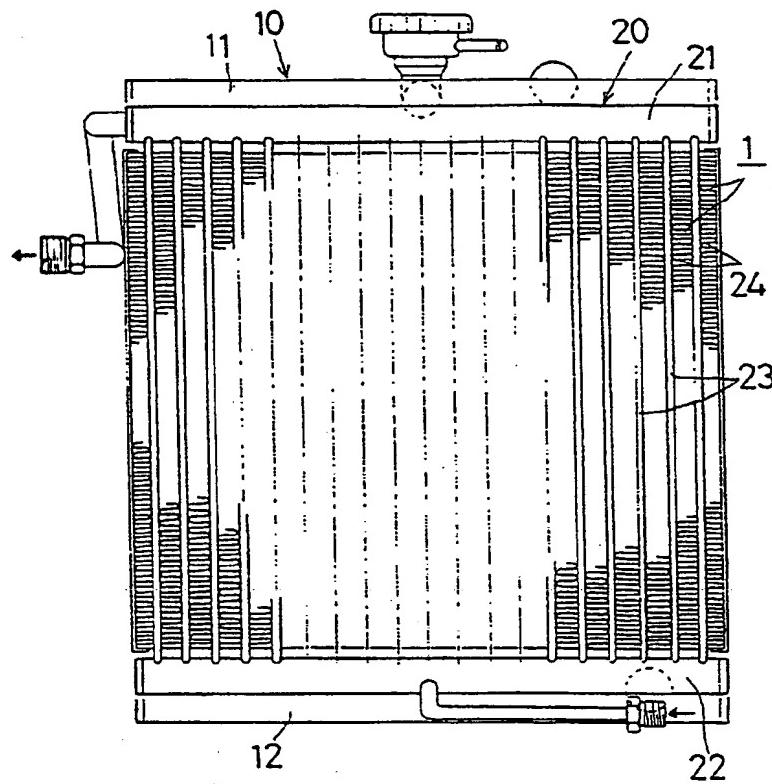


FIG. 6  
(Prior Art)

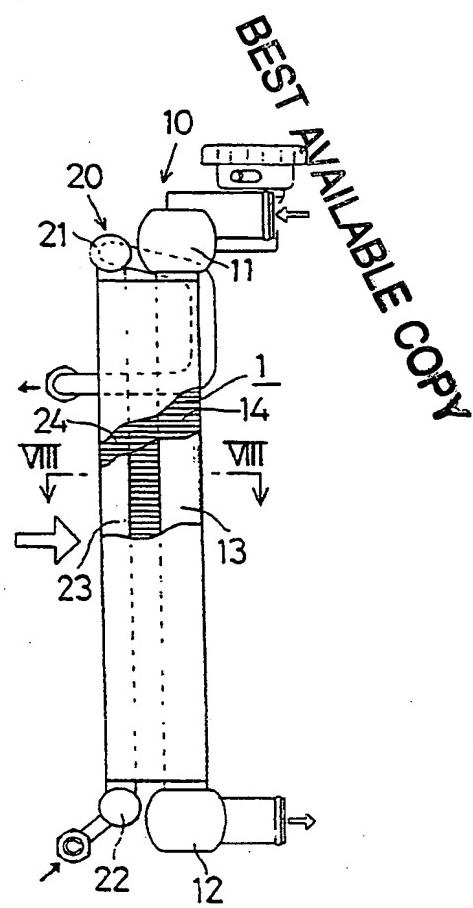


FIG. 7  
(Prior Art)

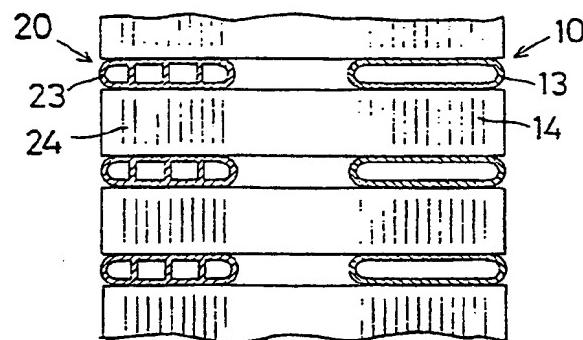


FIG. 8  
(Prior Art)



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## EUROPEAN SEARCH REPORT

Application Number

EP 90 31 3195

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.5)						
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim							
P, X	EP-A-0 367 078 (SANDEN) * Whole document * ---	1, 2, 6, 7	F 28 D 1/053 F 28 F 1/12						
A	GB-A-1 027 366 (SVENSKA METALLVERKEN) * Whole document * -----	1							
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)						
			F 28 D F 28 F						
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>THE HAGUE</td> <td>19-02-1991</td> <td>SMETS E.D.C.</td> </tr> </table> <p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>				Place of search	Date of completion of the search	Examiner	THE HAGUE	19-02-1991	SMETS E.D.C.
Place of search	Date of completion of the search	Examiner							
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